

## Atomic Spectroscopy 2-Flame Tests

### Introduction

A number of common metallic elements emit light strongly in the visible light region when ions of the metals are excited. The spectra can be studied using the same sort of simple spectroscope that was used to study bright line spectra in the previous lab.

A number of metallic elements from Groups I and II have especially bright emission lines in the visible light region. The emissions are so strong and characteristically colored that these elements can often be recognized by the gross color they impart when aspirated into a burner flame, even without the use of a spectroscope. For example, lithium ions impart a red color to a burner flame, sodium a yellow/orange color, potassium ions a violet color, calcium ions a brick red color, strontium ions a brighter red color, and barium ions a green color. Upon examination with a spectroscope, it is noted that the spectra of these ions contain several additional lines, but generally the *brightest* line in the spectrum viewed through the spectroscope corresponds to the gross color imparted to a flame when the spectroscope is not used. Naturally, when several of these ions are present together in a sample (as happens with real samples very commonly), one color may mask another so that direct visual identification of the ions may not be possible. In this case, only a calibrated spectroscope can determine what elements are present. This is done by comparing the positions of lines in the spectrum of the unknown mixture with the positions of lines in known single samples of the ions in question.

In this lab, you will excite the ions of each of the elements listed earlier, using a Bunsen burner. You will observe both the gross color imparted to the flame and the spectral lines emitted by the elements as viewed through the spectroscope. You will then determine what elements of those tested are present in an unknown mixture.

This lab will use the same method that you used last year. In this method, a wire loop is used to pick up a drop of metal solution, and the drop is then placed into the flame for vaporization. This method is simple and requires little equipment, but it produces only a brief burst of color before the sample evaporates completely. So be sure to flame samples multiple times until you are sure what the spectrum for that ion solution looks like.

### Materials

Bunsen Burner	Spectroscope	Nichrome® Wire Flame Testers	6 M HCl
0.1 M Solutions of:	Lithium Nitrate Potassium Nitrate Copper Nitrate	Sodium Nitrate Strontium Nitrate	Calcium Nitrate Barium Nitrate

### Procedure

Obtain several Nichrome® wire loops, soak the ends with 6 M HCl to remove any oxides present, rinse in distilled water, and then heat the loops in the oxidizing part of the burner flame. Be sure to heat the wire until no color is imparted into the flame. Also obtain solutions of the ions to be used. For each ion, place a drop of solution on the wire and heat it in the hottest part of the flame. Record the gross color imparted by the flame. Then repeat the process while viewing through the spectroscope, recording the approximate positions of the spectral lines (you do not need to take exact measurements).

In a ceramic well plate make combinations of the following ionic solutions:

potassium nitrate and sodium nitrate  
calcium nitrate and potassium nitrate

lithium nitrate and sodium nitrate

Repeat the same procedure for the mixtures as stated above, recording the gross color and the approximate position of the spectral lines. Also test the unknown ion solution as well and use the color as well as spectral line positions to identify the unknown.

Be sure to record all data in a table in your lab notebook.

### Questions

1. How did the *gross* colors imparted to the flame by the metal ion solutions compare with the *individual spectral lines* you observed for each element? Did the gross color result from a *combination* of spectral lines or from *one* particularly intense spectral line?
2. Of the metal cations tested, sodium usually gives the brightest and most persistent color to the flame. What problems would this introduce if a real mixture containing both sodium and other cations were to be analyzed by the technique used in this experiment? How could these problems be solved?